Report for 2002NJ9B: Human Components of Exotic Species Invasion in Urban Forested Wetlands

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Report Follows:

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Problem and Research Objectives:

While it has become dogma that urbanization promotes exotic invasion, my preliminary studies reveal that there is a significant difference in the number of exotics and the extent of invasion among wetland patches in the urban environment. These differences appear to be associated with the type of land use around the wetland and the activities that take place within the wetland. For a wetland to be invaded, particular conditions needs to be met. There must be an exotic seed source, that seed must be able to disperse into the wetland, successfully germinate and establish a seedling. That initial population must then have the ability to spread to other parts of the wetland. Further research is needed to explore the relationship between the presence of exotics in urban remnants and specific anthropogenic disturbances. By examining exceptions to the rule, a better framework for understanding invasibility can be advanced.

The objectives of my research are as follows:

1) Record the richness, density and distribution of exotic species in urban wetlands in different land use settings that are subject to varying levels of human use. (This part of the research was completed in the summer of 2001)
2) Determine the mechanism by which adjacent land use and interior human use affects the invasibility of urban wetlands at each step on invasion.
3) Verify whether land use and human use favor particular dispersal characteristics of both native and exotic species.
4) Determine if the mechanism by which land use and interior human use increase invasibility are the same.

Methodology:

The proposed research will test my hypotheses by examining the invasibility of forested wetlands (Cowardian Class PF01) in the Arthur Kill drainage basin in the central and northeastern New Jersey piedmont. The Arthur Kill watershed is appropriate for urban studies because it lies within one of nation's most densely populated and longest developed urban regions. At a population density of 5,326 people per square mile, it is 5 times more densely populated than New Jersey as a whole (the nation's most densely populated state) and 75 times denser than the nation's average (Greiliey 1993). The area, which has been settled since the 1660's, has a very long and diverse history of development (Wacker and Clemens 1995). However, amid the industry and residences relatively undisturbed habitat still exists, particularly wetlands, which were passed over by development (including a few of the largest intact tracts of open space in central and eastern New Jersey). Most importantly, the sheer number and diversity of shapes, sizes, and land use settings of forested wetlands in this highly urbanized region allows for a variety of ecological issues to be addressed.

Within the Arthur Kill watershed, I have a total of 17 study sites broken into several categories based on size and landscape position. Sites were selected by using NJDEP wetland inventory maps and aerial photographs, followed by a field visit for ground verification of site condition. I separated study sites into large (>50ha.) and small

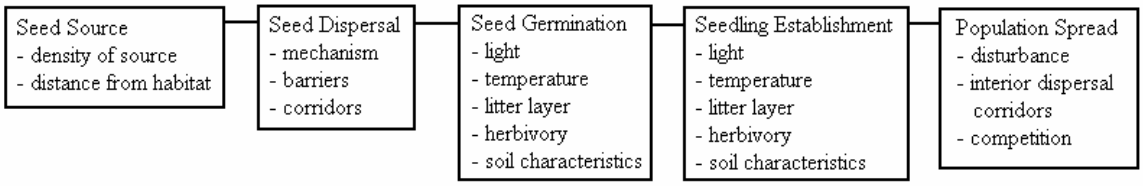
(<20 ha.) wetlands. Within the small category, wetlands have been separated by land use categories (residential vs. industrial) and shape/position categories (narrow riverine corridor vs. round, disconnected from a major waterway). All possible large study sites are within residential areas. Land use categories are determined by using aerial photographs and zoning designation. Through this approach, comparisons between categories can be made in addition to characterizing overall patterns.

I have conducted an extensive vegetation survey of each of these sites to characterize the species richness and density of native and exotic plant species. Sampling plots were located along two edges and within the interior along disturbances (trails and ditches) and in areas undisturbed by trails and ditches. Additional measurements were made to further describe the habitat including edge characterization, basal area, canopy density, and bareground and trash cover estimates. A checklist of hydrological indicators was used to estimate past and present hydrological conditions.

Through this vegetation survey, I determined that riverine corridor wetlands were the most highly invaded, an expected result due to the high amount of edge and natural disturbance in these wetlands. However, the most interesting pattern to be revealed by my study was the striking difference between wetlands surrounding by residential and industrial land use. Wetlands surrounded by residential land use had a significantly higher richness and density of exotic species than wetlands surrounded by industrial land use.

Having established a very interesting and unexpected pattern of invasibility in these wetlands, I now plan to perform several studies to determine what differences in these sites have resulted in differences in invasibility. Considering that many of these wetlands have the classic factors which should increase invasibility (high perimeter to area ratio, anthropogenic influence, pollution, and a long history of disturbance), why are some uninvaded? The answer to this question will not only aid in the formation of a more comprehensive theory of invasibility, but also give insight into how communities in urban ecosystems are structured.

For an invasion by an exotic plant species to occur, certain criteria need to be satisfied. At each stage of invasion, there are factors that could either increase or decrease the likelihood of that species continuing to the next stage of invasion. In order to determine why some wetlands are invaded while others are not, I need to carry out studies that address each of these factors. The flow chart below outlines each stage and possible factors that support and/or hinder the invasion process.



S*eed Trap Study*

Knowing the dispersal range, variations in seed rain, and the kind of propagules and their adaptations are essential for the understanding of the dynamics of both aboveground vegetation and the seed bank (Spence 1990). The collection of seeds is necessary to begin to determine if dispersal is the most important affect of land use (Ranney and Johnson 1997, Brothers and Spingarn 1992). Seed traps have been set at each initial sampling plot in the same configuration as vegetation sampling in 4 sites, 2

residential and 2 industrial. I will need to continue to monitor these traps on a weekly basis through the fall and then beginning again in the spring through the growing season for a full year of investigation. The results from this study will determine if seeds are entering the site at different sampling areas, how many seeds, which species, and propagule type (native and exotic). Further analysis will determine if seeds with particular life history characteristics are favored in some areas and what this means for invasibility and wetland regeneration.

Seed Bank Study

Although there are a total of 32 seed traps per site, they will only trap a fraction the of the seeds coming into the site and will most likely not capture any rare dispersal events which can be very important in population establishment. Therefore it is necessary to also conduct a seed bank study to track both past and present dispersal events. Seed banks often differ from the standing vegetation and are important factors in the regeneration of a community after disturbance (Leck et al. 1989). Soil from each of the 4 selected wetlands will be collected near each of the seed collection site to allow a direct comparison between standing vegetation, seed input, and viable seeds in the seed bank. The soil will spread onto flats and be exposed to a range of optimal conditions in terms of moisture and photoperiod in the greenhouse. Seedlings will be counted and identified.

Soil Survey and Hydrological Conditions

Soil characteristics determine what species can grow, where it can grow, and where it will be successful in producing the next generation. In wetlands, the hydrological conditions can be an important determinant in the soil characteristics of these sites. Many of these sites have been ditched and the hydrological regime disturbed. The soil may have been compacted or polluted. These factors may be important in determining whether a wetland is invasible. To further characterize these sites, I will collect soil from both the interior and edge of each site, measure litter and organic layer, and describe soil color and texture. I will measure bulk density, compaction, and organic content of the soil. Finally, I will have a battery of nutrient and metal analyses performed by the Rutgers Soil testing lab. Differences in soil conditions may indicate conditions that may encourage or discourage establishment by exotic species.

Seed Germination and Seedling Establishment Experiment

Studying the role of seed dispersal in invasibility is important because the pattern of seed-dispersion not only determines area of potential plant recruitment but also sets the stage for post-dispersal processes including germination, predation, competition, and reproduction (Cadenasso and Pickett 2001). Although it is necessary for exotic propagules to enter an area if it is to be invaded, the presence of appropriate microsites to germinate and grow is just as important. Exotic species are rarely considered selective when it comes to habitat preference, however in a highly urbanized wetland the appropriate conditions may not be present. To determine whether exotic seeds can germinate and grow, particularly in the industrial sites where they are not present, I will plant exotic seeds in the four wetlands in which the seed trap study was conducted in the same configuration. A subset of common exotics will be used including *Rosa multiflora*, *Alliaria petiolata,* and *Microstegium vimineum*. In each 2 x 2 meter plot, seeds of all 3 species will be set out in the spring of 2002. Half of the plot will be caged to eliminate

predation. The plots will be tracked through out the summer to determine how many germinate and establish seedlings.

Principal Findings and Significance:

All of the studies that I proposed were planned for two years and will continue through the growing season of 2003. However, I am able to report on some preliminary findings. In my seed trap study, I have found that industrial wetlands have a higher number of seeds entering the wetland, but they are primarily from one species (*Betula populifolia*). If this one species is excluded, residential wetlands have a higher number and diversity of seeds entering the wetland. At the conclusion of this study, I will determine whether land use affects the type of seeds that are common and which type of wetland has a higher number of exotic seeds. In connection with my seed trap study, I will have two years worth of seed bank studies to further add to our knowledge of seed dispersal in urban wetlands. My preliminary findings show that residential wetlands have a higher number of seed germinating in the seed bank plots. Also, more grasses, sedges and rushes are found in the seed bank than typically found in the sites. In my seed germination and seedling establishment study, I was able to germinate one exotic species (*Rosa multiflora*) in all of the field sites and seed addition plots in the greenhouse. This supports my hypothesis that it is seed dispersal as determined by land use, not within site conditions, that are driving the differences in community invasibility.